#1956 THE INSTITUTE OF PAPER CHEMISTRY
(Study of Coater)
Project Reports (8)

PROJECT REPORT FORM

PROJECT NO. 1956
COOPERATOR I.F.C.
REPORT NO. 37
DATE
NOTE BOOK 1819
PAGE 13 TO
SIGNED Frans Vaurio
Frans Vaurio

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TRAILING BLADE COATING

This report describes the submicroscopic character of a clay-latex coating as applied by a trailing blade to paper.

The two views (Figure 1 and Figure 2) represent surface replicas of a clay coating (applied by the trailing blade technique) at 22,000X magnification. This is probably the first attempt to do this at The Institute of Paper Chemistry. The fact that the adhesive contained a styrene-butadiene copolymer latex made it necessary to use a special technique for replication.

Miss Olga Smith found that a sputtered carbon film allowed separation of the surface replica from the polystyrene plastic used to get the impression of the surface. The following detailed procedure was used.

Steps to Make a Carbon-Film Replica
of a Clay-Coated Surface

1. Shadow cast the coating with chromium.
2. Carbon film the shadowed coating to a faint-to-medium gray.
3. Melt a pellet of polystyrene to form a disk about 3/8 inch diameter x 1/32 inch thick on a glass microscope slide. Flatten by pressing it with another glass slide.
4. Heat the disk until it is so soft that an indentation made with a pin will heal. Place the coated paper, carbon side down, on the heated polystyrene disk. Press firmly (by hand) to assure good contact.

5. Remove the disk from the slide. Soak in water.

6. Under a dissecting microscope pull off the paper. [Soak in 20% NaOH if sticking.] [If still sticking, put in 30% HCl.] Wash thoroughly in distilled H_2O. The carbon film remains stuck to the disk.

7. Score the disk into about 1/8 inch areas with a razor blade.

8. Place a small section in ethylene dichloride in a shallow dish. Push the disk to the bottom so that the disk sticks to the bottom of the dish. The carbon film will float to the top as the plastic dissolves. (It is not necessary to let the plastic disk dissolve completely.)

9. Place the carbon film on a collodion filmed grid. [Place the grid and film on a copper screen support to dissolve away excess collodion.] [Can also place grid on filter paper.]

The view shown in Figure 1 represents a less complete removal of the adhering coating than that in Figure 2.

The latex may be observed as small dark globules stuck together in chains and mosaics. The adhesive distribution is apparently not ideal. There is need for study of formulating clay-adhesive mixtures for use in the trailing blade process of coating paper.

fv/bl

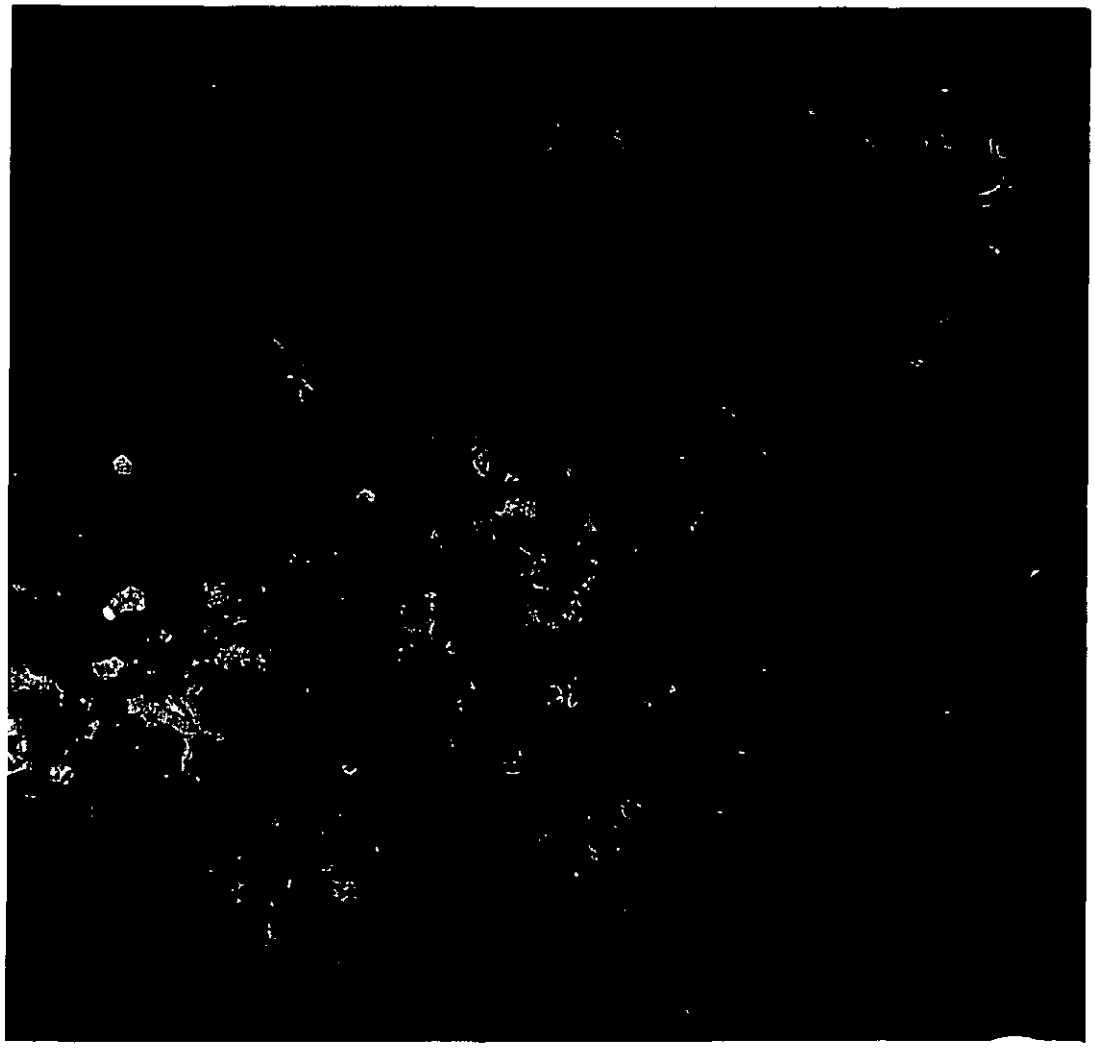
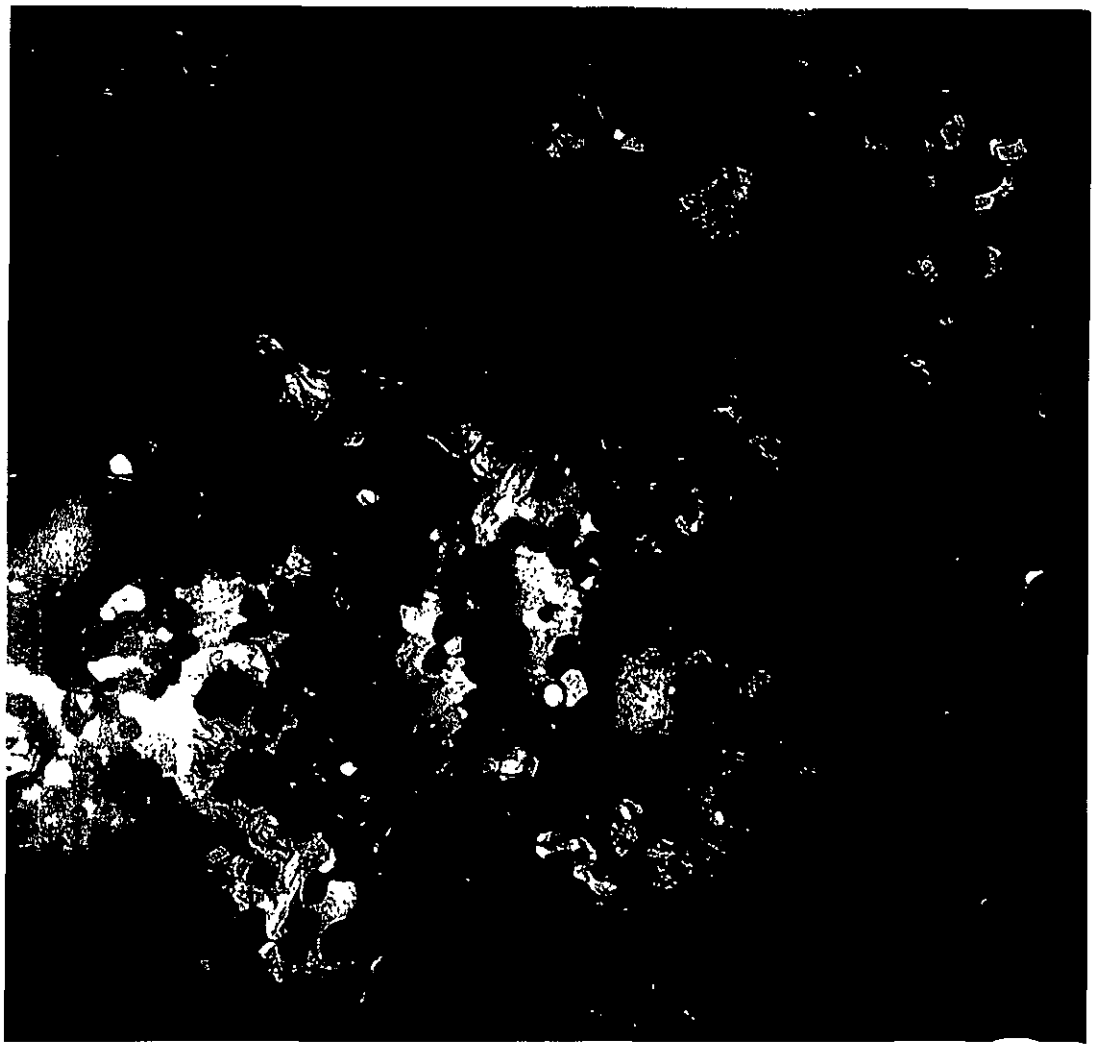


Figure 1



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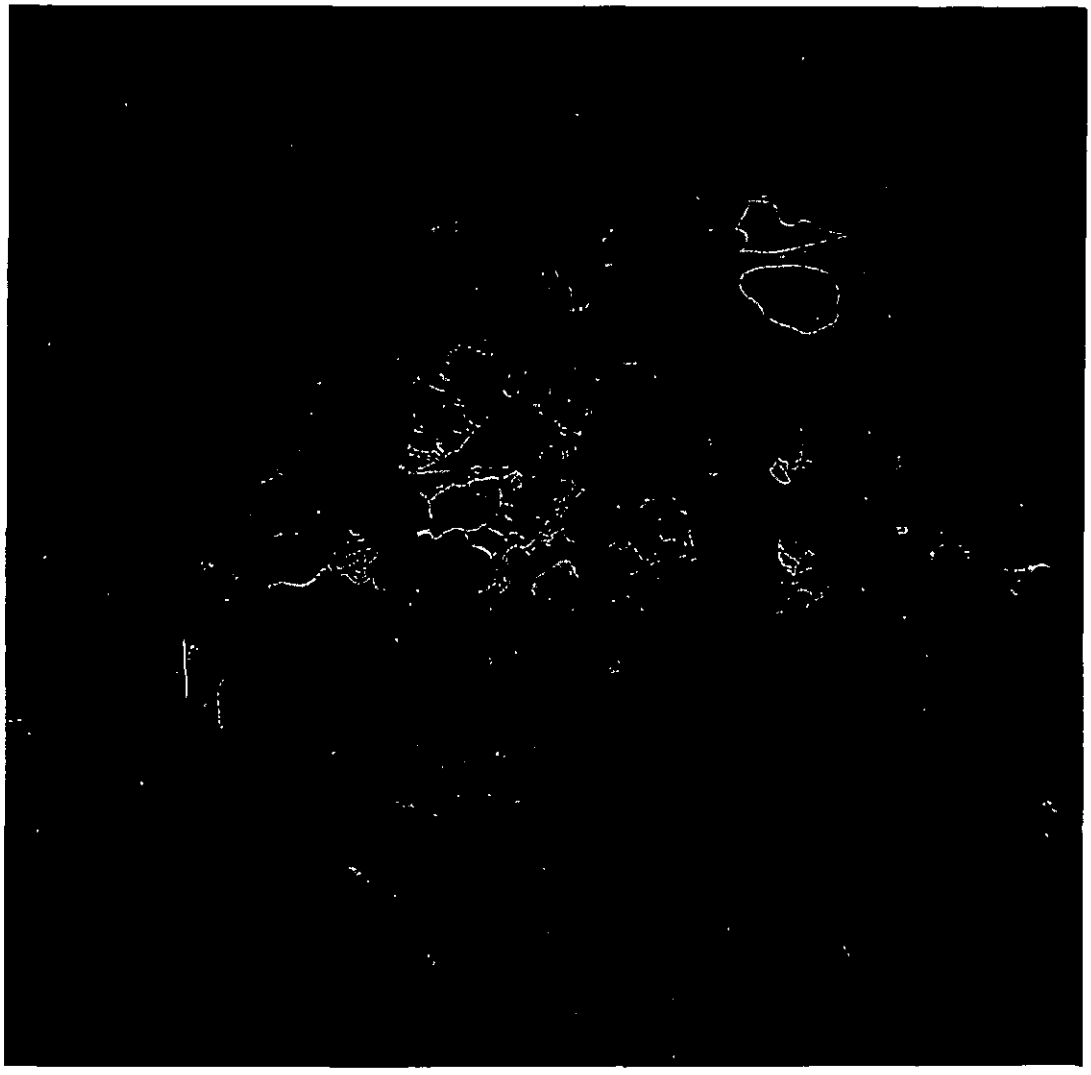
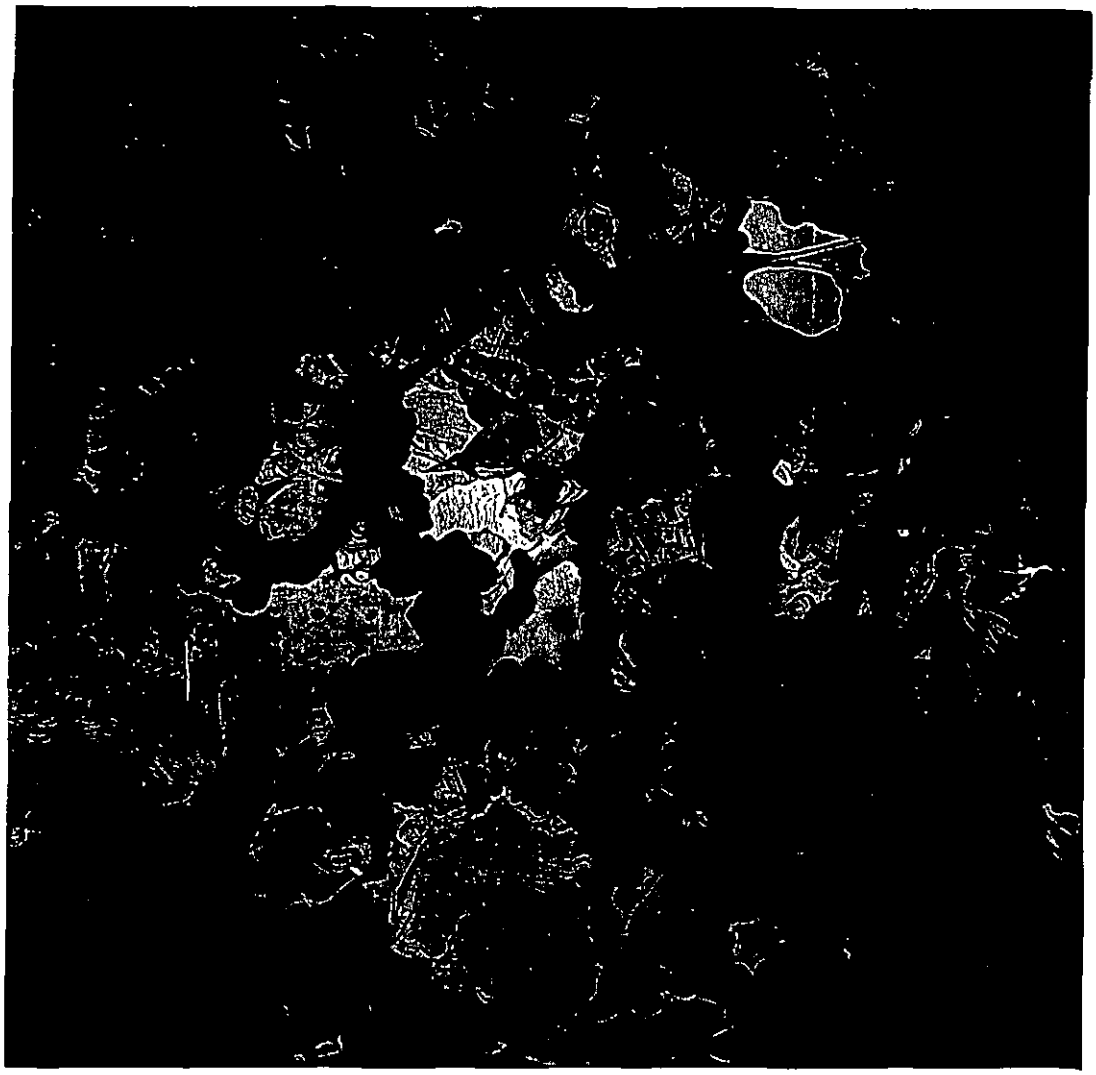


Figure 2



PROJECT REPORT FORM

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L. E. Leporte

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TRAILING BLADE, AIR KNIFE, AND TANDEM TRAILING BLADE AND AIR KNIFE COATING EXPERIMENTS CONDUCTED BY PACKAGING CORPORATION OF AMERICA

INTRODUCTION

On August 3, 4, and 5, Messrs. Don Voigts, Technical Director, Russ Larson, Technical Assistant in charge of experimental and machine coating, and Bob Long, staff member, of the American Box Board Division of Packaging Corporation of America conducted a series of experiments with the Institute coater under Special No. 11,289. They were assisted in the coating trials by Bill Gutowski, coating technician with Packaging Corporation, Don Fird, and the writer. Dr. Howells and Frans Vaurio were present during some of the runs.

Packaging Corporation of America produces a blended board containing 60% bleached kraft and 40% cold soda pulp which is deficient in smoothness and printability due to the presence of shives on the surface. This is a 14-point board normally calipering 17 mils. It was their purpose in using the experimental coater to investigate the utility of a double coating application to cover the shives and improve the gloss ink hold-out.

PROCEDURE

In these trials, two boards were used; the blended board and solid bleached kraft board. Both boards were uncalendered and uncoated before use.

Basically, two clay-protein coatings were used, one containing Rhoplex as a binder and the other containing Dow Latex as a binder. We were given samples of the coating and the following information.

Air knife coatings:

1. Rhoplex protein-clay coating (Designation R)
   Solids 44.8%
   Binder 19%
   Viscosity (Brookfield) 60 r.p.m., 75°F. 100 cps.

2. Latex protein-clay coating (Designation L)
   Solids 43.2%
   Binder 19%
   Viscosity (Brookfield) 60 r.p.m., 75°F. 250 cps.

Trailing blade coatings:

1. Rhoplex protein-clay coating (Designation R)
   Solids 60.3%
   Binder 16%
   Viscosity (Brookfield) 60 r.p.m., 75°F. 664 cps.

2. Latex protein-clay coating (Designation L)
   Solids 54.2%
   Binder 16%
   Viscosity (Brookfield) 60 r.p.m., 75°F. 820 cps.

Samples of three of these coatings (the Trailing Blade Rhoplex coating spoiled before it could be tested) were sent to the Physical Chemistry Department for Hercules rheograms. Apparent viscosities for the three coatings were as follows:

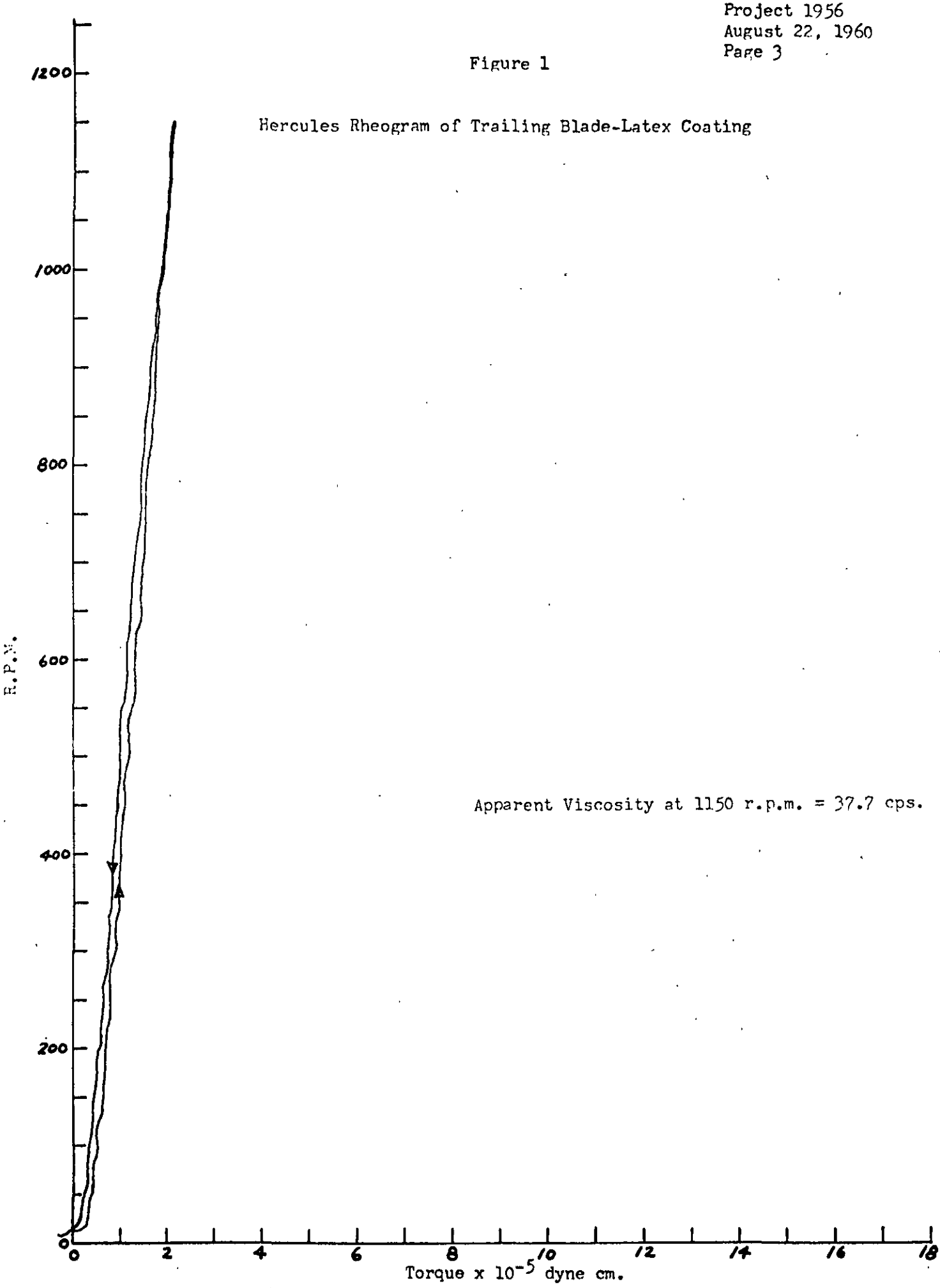
Trailing blade latex	37.7 cps.
Air knife latex	18 cps.
Air knife Rhoplex	12.6 cps.

Rheograms for these coatings are given in Figures 1, 2, and 3.

The desired coating weight for those trials involving air knife and the trailing blade operating in tandem was 12 lb. per 3000 square feet.

Figure 1

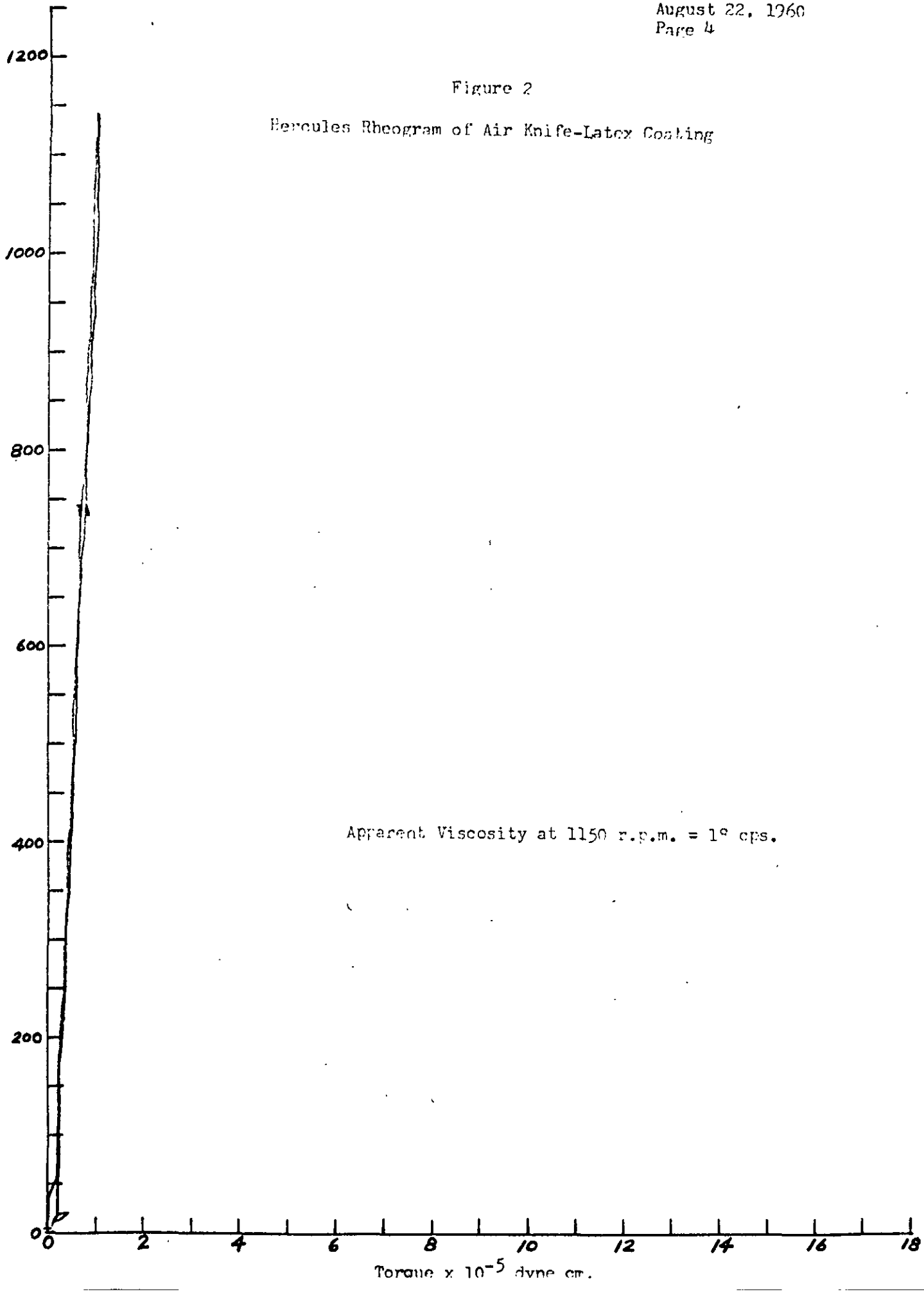
Hercules Rheogram of Trailing Blade-Latex Coating



Apparent Viscosity at 1150 r.p.m. = 37.7 cps.

Figure 2

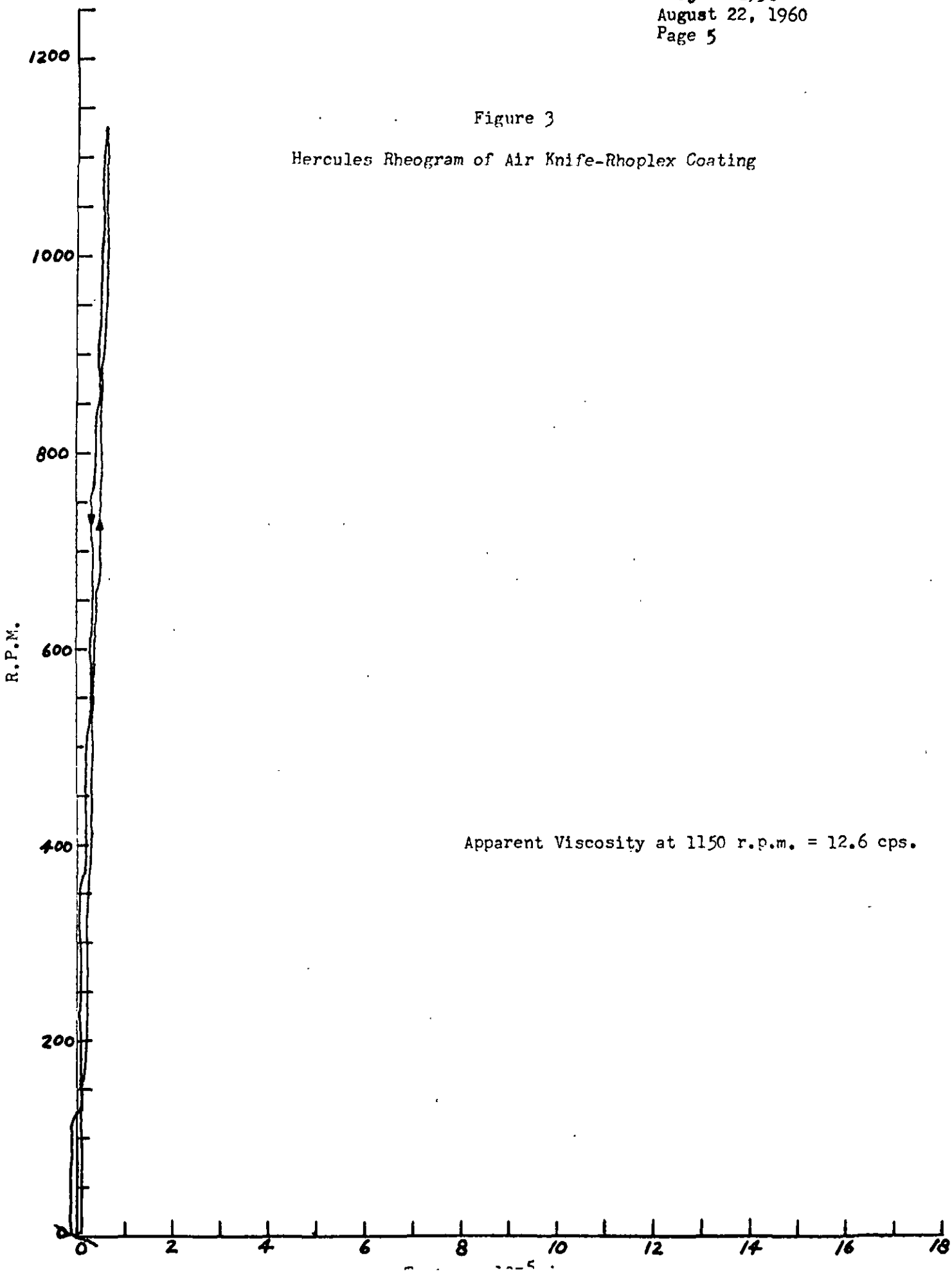
Hercules Rheogram of Air Knife-Latex Coating



Apparent Viscosity at 1150 r.p.m. = 19 cps.

Figure 3

Hercules Rheogram of Air Knife-Rhoplex Coating



Apparent Viscosity at 1150 r.p.m. = 12.6 cps.

The air pressure on the air knife was varied from 3/4 to 1-1/2 lb. p.s.i.; the web clearance was 1/8 inch; and the knife opening was 0.030 inches. During the early runs with the air knife, it was found necessary to tape the outside edges of the knife opening to control spattering of the coating.

The blade on the trailing blade was extended 13/16 inch and adjusted to give 1/8 flex when in contact with the web; the air pressure on the operating cylinder was 90 p.s.i. Some difficulty with the felt seals and the dams was experienced as they tended to leak, resulting in heavier coating beading on one or both edges of the stock; these beads would not be dry at the rewind roll and blocking would result.

The web speed was maintained at 100 feet per minute with some short runs at 180 feet per minute. In every case, at the higher speeds the coated board blocked on the rewind rolls.

The infrared heaters were set at their maximum temperatures of 650°F. and spaced as close as practicable to the web. They had to be adjusted several times during a run as the web had a tendency to curl with the coated side to the outside of the curl.

The machine thread-up for the air knife-trailing blade tandem coating is shown in Figure 4.

The trailing blade coating was fed by pouring small amounts from a stainless steel beaker into the fountain. The air knife coating was recirculated to a 50-gallon surge tank, the coating level in the pan being maintained by an overflow pipe.

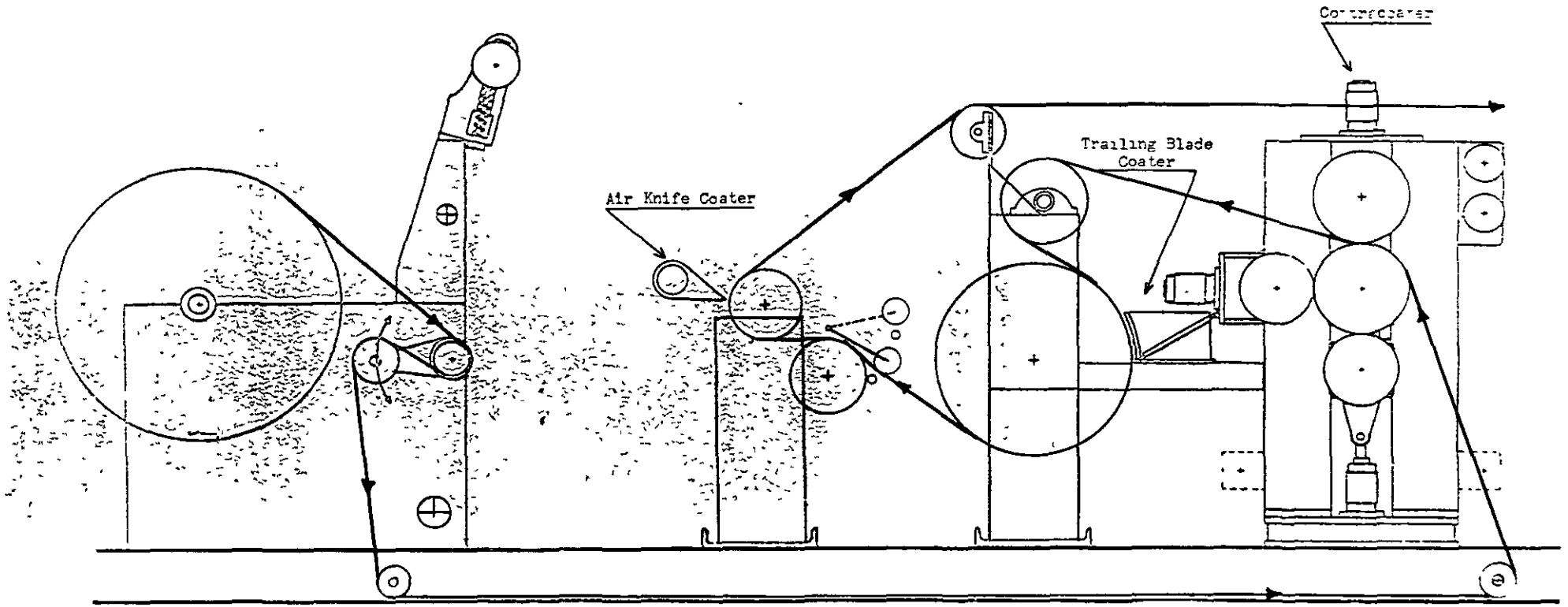
The procedure for making runs was to begin coating with the air knife alone and when a sufficient amount of board had been coated, the

Figure 4

Machine Thread-up

THE INSTITUTE OF PAPER CHEMISTRY EXPERIMENTAL COATER

Assembly of Coaters



trailing blade would be put into operation. When coating with the trailing blade alone was desired, the web would be broken at the trailing blade station and the air knife station and spliced so that the air knife station was no longer in the web train. This procedure was followed for both types of board and the two types of coating formulation.

Coating weights were determined by comparing the weights of six coated samples cut with a 3.4844 inch I.D. circle die with a blank of the same board stock cut with the same die. The weight difference times 100 gave the coating weights in lb. per 3000 square feet. Samples were placed in an oven at 105°C. before weighing and weighed on a hot balance.

Coating conditions and coating weights for each run are summarized in Table I.

RESULTS

Nearly all of the runs at 100 f.p.m. web speed seem to have good coatings and although not completely dry at the rewind, the coated board did not seem to block. Exceptions were streaks caused by a build-up of dewatered coating on the trailing blade; streaks resulting from coating spatter on the air knife opening; and beads caused by leakage of the edge dams on the trailing blade fountain. In runs at 180 f.p.m. blocking would occur at the rewind; however, the board would not be wet but it would feel definitely damp to the touch. No samples of the coated board were obtained.

TABLE I

SUMMARY OF COATING RUNS

Run	Board	Coating	Side Coated	Coating Method	Air Pressure (Air Knife) p.s.i.	Web Speed[1] ft./min.	Coating Weight lb./3000 ft.[2]	Comments
1	Blended	Rhoplex	Wire	Air Knife	1.5	100	--	
2	Blended	Rhoplex	Wire	Air Knife	1.0	100	9.7	
3	Blended	Rhoplex	Top	Air Knife	1.0	100	7.38	Taped edges of air k to reduce spatter
4	Bleached Kraft	Rhoplex	Wire	Air Knife	0.75	100 180	15.1 at 180 fpm	Short run at 180 f.p. blocking resulted
5	Bleached Kraft	Rhoplex	Top	Air Knife	0.75	100	12.56	
6	Bleached Kraft	Rhoplex	Top	Trailing Blade and Air Knife	1.5	100	12.3	Air pressure on air knife dropped to 1 p. during run.
7	Bleached Kraft	Rhoplex	Top	Trailing Blade		100	2.39	Some trouble with bui up of coating on edge of board.
8	Bleached Kraft	Rhoplex	Wire	Trailing Blade		100	4.52	
9	Bleached Kraft	Rhoplex	Wire	Trailing Blade and Air Knife	1.0	100	13.09	
10	Blended	Rhoplex	Wire	Trailing Blade and Air Knife	1.0	100	15.43	
11	Blended	Rhoplex	Wire	Trailing Blade		100	7.66	
12	Blended	Rhoplex	Top	Trailing Blade and Air Knife	1.0	100	14.04	

TABLE I (Continued)

Summary of Coating Runs

Run	Board	Coating	Side Coated	Coating Method	Air Pressure (Air Knife) p.s.i.	Web Speed[1] ft./min.	Coating Weight lb./3000 ft.[2]	Comments
13	Blended	Rhoplex	Top	Trailing Blade		100	4.14	
14	Bleached Kraft	Latex	Wire	Air Knife	1.5	100	8.83	
15	Bleached Kraft	Latex	Wire	Trailing Blade and Air Knife	1.3	100	9.19	
16	Bleached Kraft	Latex	Wire	Trailing Blade		100	2.26	
17	Bleached Kraft	Latex	Top	Air Knife	0.75	100	9.27[2]	
18	Bleached Kraft	Latex	Top	Trailing Blade and Air Knife	1.0	100	10.67	
19	Bleached Kraft	Latex	Top	Trailing Blade		100	1.40	
20	Blended	Latex	Wire	Air Knife	0.88	100	14.89	
21	Blended	Latex	Wire	Trailing Blade and Air Knife	0.88	100	12.75	
22	Blended	Latex	Wire	Trailing Blade		100	4.89	
23	Blended	Latex	Top	Air Knife	1.0	100	14.61[2]	
24	Blended	Latex	Top	Trailing Blade and Air Knife	1.0	100	14.99	
25	Blended	Latex	Top	Trailing Blade		100	0.38	

[1]Runs at 180 f.p.m. other than the one noted were not recorded because of the short duration of the runs and the little value of the coated board due to blocking.

[2]Coating weights were determined from the difference between the coating weights of the air knife and trailing blade coated board and the trailing blade coated board of the same series of boards and coatings.

PROJECT REPORT FORM

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L. E. Leporte

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COATING OF GLASSINE WITH VAPOR-RESISTANT HEAT-SEALABLE RESINS

INTRODUCTION

On May 22 and 23, 1961, Messrs. Herbert Wenberg and James Hickey of the Nicolet Paper Company were at the Institute to conduct a series of coating trials. These trials were conducted under Special No. 11,417; Mr. Frans Vaurio was in charge of the project. Messrs. Wenberg and Hickey were assisted in their experiments by Donald Fird and the writer.

The purpose of these trials was the evaluation of three resins: National Starch Company Resin 3600, Rohm & Haas Rhoplex R-9, and Dewey and Almy Daran 202; and a concurrent evaluation of three methods of applying them: Reverse Roll, Air Knife, and Trailing Blade. These are polyvinyldine chloride resins. The intended use for glassine coated with these materials would be as a fill-and-seal packaging material to be used to produce such items as potato chip bags.

PROCEDURE

The base stock used in these trials was 30 lb./3000 ft.^{2} bleached glassine containing 6% plasticizer, of which 4% was urea and 2% was sodium nitrate.

The first trials were made with application of the Resin 3600 by

means of the reverse roll. After the initial run, it was decided that the viscosity of the resin was too low (11.5 centipoises at 60 r.p.m.--Brookfield viscosity) to be suitable for contracoater application. The resin was thickened with polyvinyl alcohol to a viscosity of 115 centipoises at 60 r.p.m., and this material was used for the subsequent contracoater runs. Runs were made with varied web speeds, contracoater roll speeds, and nip settings.

All three of the resins were used in the trials involving air knife metering. The Resin 3600 and the Rhoplex R-9 were thickened to Brookfield viscosities of 100 centipoises at 60 r.p.m. for these trials. The Daran 202 was diluted from 60% solids to 57% solids (viscosity 23 centipoises at 60 r.p.m.) in accordance with instructions received in a telephone call by Mr. Vaurio to Mr. Jim Donald at the Dewey and Almy Chemical Division of W. R. Grace & Co. The air knife was used at a blade setting of 0.030 in., a breast roll-blade gap of 0.145 in., with the unit at approximately a 10-degree angle with the horizontal and the orifice one inch below the centerline of the breast roll. The only variable in these runs was the web speed, which was varied from 30 to 125 feet per minute.

Two runs were made with the trailing blade using the Daran 202 thickened to a Brookfield viscosity of 200 centipoises at 60 r.p.m. with polyvinyl alcohol. The trailing blade was adjusted to 13/16 inch extension, with the deflection of the blade set by having 1/8 inch overshoot beyond initial contact with the breast roll. Web speeds were 100 feet per minute and 320 feet per minute for the first and second run, respectively.

Data for all of these trials are given in Tables I, II, and III.

TABLE I

SUMMARY OF COATING RUNS WITH CONTRACOATER

Run No.	Coating	Viscosity, cp. (Brookfield at 60 r.p.m.)	Nip Adjustments, inches			Roll Speeds, f.p.m.			Web Speed, f.p.m.	Remark
			Applicator	Applicator-Meter	Applicator-Backing	Pan	Applicator	Meter		
1	Resin 3600	11.5	0.010	0.006	0.002	51	56	26	56 slowed to 40	Drier init 300°F. inc Daylight b applicator wrinkling Coating mo
2	Resin 3600	115.	0.010	0.006	0.002	51	56	26	30	Drier set coating, w Coating we 3000 ft.²
3	Resin 3600	115.	0.008	0.002	0.002	51	35	26	varied from 20 to 200 f.p.m.	Drier set Web wrinkl
4	Resin 3600	115.	0.008	0.004	0.002	51 incr. to 74	101	51 incr. to 56	-	Backing ro creased fr 25 p.s.i. Coating we 1.5 lb./30
5	Resin 3600	115.	0.008	0.004	0.002	123	100	54	100 slowed to 80	Drier set (650°F.). weight 3.5
6	Resin 3600	115.	0.008	0.004	0.002	74	100 decreased to 56	56	50 slowed to 30	Drier set At 50 & 30 rewinding until appl speed was began to scorch when applica was decreased to 56 f.p.m. w at 30 f.p.m. Coating weight 56 f.p.m., web 30 f.p.m.) 0.

TABLE I

SUMMARY OF COATING RUNS WITH CONTRACOATER

Viscosity, cp. (Brookfield at 60 r.p.m.)	Nip Adjustments, inches			Roll Speeds, f.p.m.			Web Speed, f.p.m.	Remarks
	Applicator	Applicator-Meter	Applicator-Backing	Pan	Applicator	Meter		
11.5	0.010	0.006	0.002	51	56	26	56 slowed to 40	Drier initially set at 300°F. increased to 400°F. Daylight between pan and applicator rolls. Severe wrinkling of web at rewind. Coating mottled
15.	0.010	0.006	0.002	51	56	26	30	Drier set at 500°F., smooth coating, web wrinkled. Coating weight: 32 lb./3000 ft.^{2}
15.	0.008	0.002	0.002	51	35	26	varied from 20 to 200 f.p.m.	Drier set at 500°F. Web wrinkled
15.	0.008	0.004	0.002	51 incr. to 74	101	51 incr. to 56	-	Backing roll pressure decreased from 45 p.s.i. to 25 p.s.i. Mottled coating. Coating weight 1.2 to 1.5 lb./3000 ft.^{2}
15.	0.008	0.004	0.002	123	100	54	100 slowed to 80	Drier set at max. temp. (650°F.). Coating weight 3.5 lb./3000 ft.^{2}
15.	0.008	0.004	0.002	74	100 decreased to 56	56	50 slowed to 30	Drier set at max. temp. At 50 & 30 f.p.m., web was rewinding wet; no drying until applicator roll speed was decreased. Web began to scorch when applicator roll speed was decreased to 56 f.p.m. with web speed at 30 f.p.m. Coating weight (applicator 56 f.p.m., web 30 f.p.m.) 0.75 lb./3000 ft.^{2}

TABLE II

SUMMARY OF COATING RUNS WITH AIR KNIFE

Blade Opening 0.030 inches; Breast Roll-Blade Gap 0.145 inches

Run No.	Coating	Viscosity, cp. (Brookfield at 60 r.p.m.)	Air Pressure, p.s.i.	Web Speed, f.p.m.	Remarks
7	Resin 3600	100	3	50	Web broke during run; coating weight 1.8 lb/3000 ft.^{2}
8	Resin 3600	100	3, 2, 1, 0.5	50	Smooth coating, dried well with little curling. Coating weight at end of run (0.5 p.s.i. air) 5-12 lb./ 3000 ft.^{2} --pick up roll was starving due to lack of coating
9	Rhoplex R-9	105	3, 2	50	Heavier coating than applied in Run 8 at comparable air metering conditions (3 and 2 p.s.i. air). Coating weight 8.5 lb./3000 ft.^{2} at 3 p.s.i.
10	Daran 202 (diluted from 60% to 57% solids)	23	3, 2	50	Web broke while running at 3 p.s.i. and again while running at 2 p.s.i. Coating at 2 p.s.i. 7.6 lb./3000 ft.^{2}
11	Daran 202 (57% solids)	23	2	100 increased to 125	Web curled; coating weight 8.4 lb./3000 ft.^{2}

TABLE III

SUMMARY OF COATING RUNS WITH TRAILING BLADE

BLADE EXTENSION: 13/16 in.
Overshoot 0.125 in.

Run No.	Coating	Viscosity, cp. (Brookfield at 60 r.p.m.)	Pressure, * p.s.i.	Web Speed, f.p.m.	Remarks
12	Daran 202 (57% solids)	23	80	100	Edge dams leaked; build-up of what seemed to be coagulated latex at dams and blade edge. Coating weight: 1.5 lb./3000 ft.^{2}
13	Daran (57% solids)	~ 200	40	320	Edge dams leaked; severe wrinkling; coagulated latex at dams and blade edge.

* Gage pressure on cylinder driving blade and fountain into contact with web.

RESULTS

In these trials, drying and rewinding were the biggest operational problems. The glassine curled readily during drying, was easily scorched if overdried, and was difficult to dry with heavy coatings. If the material was not completely dry on leaving the drier, it would slip on the rewind core resulting in slippage on the rewind drive rolls and a poorly wound roll that had to be "slabbed off" frequently. Curling was particularly a problem when the tension was high as was the case in the Contracoater (due to the drag caused by the reverse running applicator roll) and the trailing blade methods of coatings.

Foam was prevalent in all of the coating materials. In order to inhibit the foam formation, Eldfoam 2881 (Eldorado Chemical Co.) was sprayed onto the surfaces of the coatings in the pickup reservoir; however, the coatings still tended to foam. This foam did not seem to seriously affect the coating on the glassine. The quality of the coatings were difficult to judge visually because the coatings were transparent.

Air -knife coating seemed to be the most attractive of the three methods for applying and metering coating under these conditions. Curling was less evident with this method of coating and a more even and better controlled coating seemed to have been achieved.

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L. E. Leporte

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AIR KNIFE COATING TRIALS

WITH POLYETHYLENE EMULSION

INTRODUCTION

On December 15, 1961 a series of coating trials was run for the Packaging Corporation of America. The purpose of these trials was to obtain samples of approximately 1000 sq. ft. each of nine point board coated by means of the air knife with various weights of a polyethylene emulsion, preferably 1, 2 and 3 lb./1000 sq. ft. The emulsion used was Spencer Chemical Company Poly Em thickened with Staley Napol B starch. These trials were witnessed by two representatives of the Packaging Corporation: Dr. James J. Higgens, Assistant Director of Research and Development and Mr. Dan Bergsma, Chemist and a representative of the Spencer Chemical Company, Mr. Robert C. Whitney, Senior Staff Member in Research.

PROCEDURE

The base stock used in these trials was nine point white board with a basis weight of approximately 120 lb./1000 sq. ft. supplied by the Packaging Corporation. Coating was applied to the wire side of the stock.

The polyethylene emulsion, as received, contained 40.6% solids and had a pH of 7.45. To obtain the desired viscosities for the trials, a 10%

solution of Napol B starch was made up by heating the proper amount of starch and water to 180°F for a few minutes while agitating with a "Lightnin" mixer. The starch solution was added to quantities of the emulsion on the basis of the solids content of the emulsion until the viscosity was adjusted to a level considered desirable for a trial. Viscosities were measured with a Brookfield Viscometer at 60 r.p.m. using a #2 spindle.

The air knife was set at an angle of 22° to the horizontal with the orifice located 1/4 in. below the centerline of the backing roll. The gap between the orifice and the backing roll was 0.135 in. and the orifice opening was 0.034 in. The applicator roll was set to run with the web. These adjustments were not varied during the trials.

RESULTS

Six runs were made under various conditions of coating viscosity, air pressure, web speed and applicator roll speed. These runs are summarized in Table I.

The slowest speed available on the applicator roll which is driven by a Varidrive unit is 85 f.p.m. During the first run it was found that, at the web speeds under consideration, too much coating was being applied to the web for the air knife to meter effectively. Consequently, at the end of the first run the Varidrive was replaced with a Graham drive in order to obtain slower applicator roll speeds. In the subsequent runs, it was found that a very good coating could be applied by starting a run with an applicator roll running at such a low speed that skip coating occurred and increasing the applicator roll speed just to the point where a smooth coating was observed on the web entering the drier. At this setting the surface of the roll after

TABLE I

SUMMARY OF COATING RUNS WITH AIR KNIFE

Air Knife: Orifice--0.034 inches
Backing roll--orifice gap--0.135 inches

Coating: Type--Polyethylene Emulsion
Solids--40.6% thickened with Napol B starch

Run No.	Coating: Thickener, %[a]	Coating: Viscosity, cp[b]	Air pressure, psi.	Web speed, fpm.	Applicator roll speed, fpm.	Coating Wgt. lb./3000 sq.ft.	Remarks
1	1.0	320	1.75	50	85	7.0	Vari-drive on applicator roll replaced with a Graham drive at end of run.
2	0.5	108	2.25	50	21	6.0	
3	0.5	108	2.25	100	21	6.3	
4	0.5	108	4.00	200	56	9	A short run at 510 fpm web speed (applicator roll speed not known) was included in this run.
5	1.0	235	0.75	100	34	--	
6	1.5	50[c]	2.25	100	20	--	

a/ Starch addition based on solids in emulsion.
b/ Brookfield at 60 rpm with a #2 spindle.
c/ Diluted 40% with water.

contacting the web was clean, indicating nearly 100% transfer of coating from the roll to the web.

Dry coating weights ranging from 3 to 9 lb/3000 sq. ft. were obtained. Drying of the web was no problem even during a short run at 510 fpm at the end of run 4; however, it was necessary to operate the drying units at maximum temperature (650°F) and vary the drier-web distance.

PROJECT REPORT FORM

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AIR KNIFE COATING TRIALS

CONDUCTED FOR THE APPLETON COATED PAPER COMPANY

INTRODUCTION

On January 2, 1962 several coating trials were run by Mr. Tom Busch, Technical Director, Mr. John W. Allen, Chemist, and Mr. Richard Dearstine, Research Technician of Appleton Coated and Mr. Donald P. Ford and the writer, of the Institute. The intention of these trials was to evaluate a coating material designated by Appleton Coated as Mark I. Trials were run with and without smoothing rolls. The air knife blow-off was recirculated to the color pan during some of the runs in order to determine the foaming characteristics of the coating and to investigate the use of a defoamer. The desired coating weight for these runs was 2.5 lb/3000 ft^2.

PROCEDURE

The base stock used in these trials was a Nekoosa Edwards 4 mil bread wrap having a basis weight of 23 lb/3000 sq. ft. Coating was applied to the wire side.

The following air knife settings were used throughout the trials:

Angle to horizontal: 22°

Blade position: 1/4 in. below the center-line of the breast roll.

Blade-breast roll gap: 0.129 in.

Orifice opening: 0.031 in.

These settings were consistent with production machine settings. The color roll was run with the web.

Six inch diameter smoothing rolls were mounted approximately 16 inches from the air knife. A 2-1/4 inch lifting roll was used to raise the web in order to increase the wrap around the smoothing rolls. The smoothing rolls were driven against the web, both rolls operating at equal speeds. Runs were made with both smoothing rolls operating and with the roll nearest the air knife removed. A web wrap of approximately 10° on the smoothing rolls was used with both rolls operating and with only one roll operating a wrap of approximately 30° was used.

Three variations in machine threadup were involved. These variations are shown in Figures 1, 2 and 3. The threadup in Figure 1 was used for coating trials without the operation of the smoothing rolls. Figure 2 shows the threadup used with the operation of both smoothing rolls and Figure 3 shows the threadup with one smoothing roll removed.

Coating weights were determined by the difference in ovendry weights of 10 square inch circles cut from coated and uncoated stock.

RESULTS

Samples of the coated web were taken by breaking the web during a run. This was necessary because the drying requirements for these runs were beyond the capabilities of the drier. The runs are summarized in Table I.

Table I. Summary of Coating Runs.

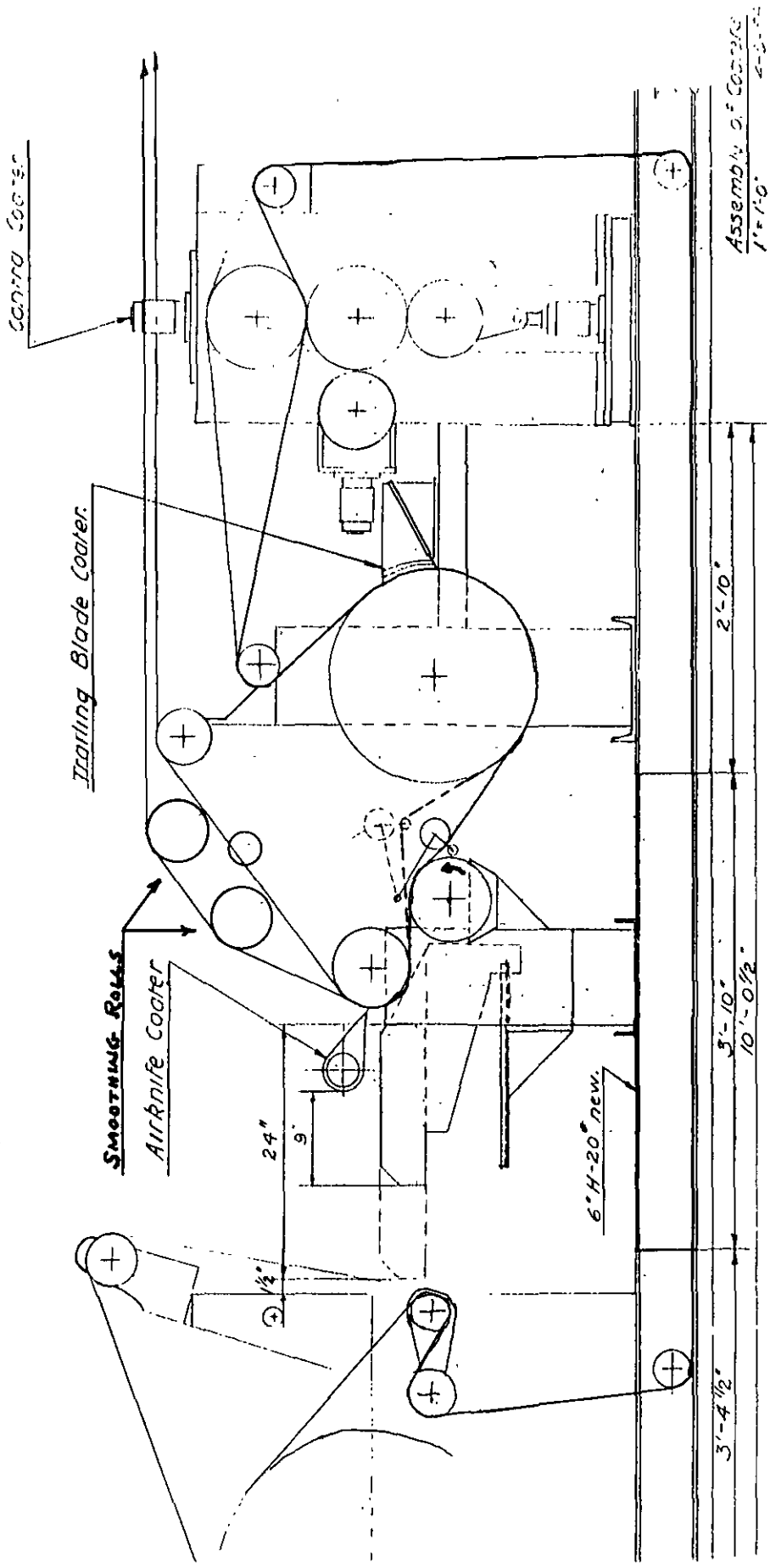
Run No.	Air Knife		Color roll speed, fpm. 2/	Air pressure, psi.	Smoothing Rolls 3/		Web Speed, fpm.	Coating Wgt., lb/ 3000 sq.ft.	Remarks
	Gap. in. 1/	Orifice, in.			No. Rolls	Speed, fpm.			
1	0.125	0.031	60	1.5	--	--	650	3.8	No drying
2	0.125	0.031	60	2.0	--	--	650	2.7	No drying
3	0.125	0.031	60	2.0	2	500	650	2.0	Driers set at max. temp.; did not dry web
4	0.125	0.031	60	2.0	1	360	650	2.5	No drying. Air knife blow-off recirculated to color pan
5	0.125	0.031	60	2.0	--	--	650	--	No drying. Air knife blow-off recirculated to color pan. 28 cc. of defoamer (50 parts eldefoam 2892 + 50 parts surfanol 104A) added to color.
6	0.125	0.031	105	2.0	--	--	650	--	No drying. Air knife blow-off recirculated to color pan. Color contained defoamer.

1/ Air knife to web distance. 2/ Rotated with the web. 3/ Rotated against the web.

The use of both smoothing rolls seemed to produce a reduction in the coating weight as the result of transfer of coating from the web to the rolls. There was not enough web wrap with both rolls operating, consequently the coated samples had a pattern of alternating lightly and heavily coated areas running in the cross direction. When one smoothing roll was removed and the wrap was increased on the remaining roll the patterned effect was not observed and acceptable coatings were obtained.

Foaming was not a problem during any of the runs, however, a defoamer was added to the color between runs 4 and 5 in order to observe any effects that it might produce in the color system. It is an interesting note that skip coating was obtained in run 5 and it was necessary to increase the color roll speed in run 6 in order to obtain acceptable coating; possibly this was the result of the defoamer addition.

Web breaks and poor rewinding were problems encountered in these runs; both problems being attributable to malfunctions in the Fife edge control. The Fife roll would either hunt or not control at all. Some maintenance, such as replacement of vacuum hoses, repair of the pump, may rectify this.



knife coating without operation of smoothing rolls. Red line indicates web. Rotational direction of driven
by arrows.

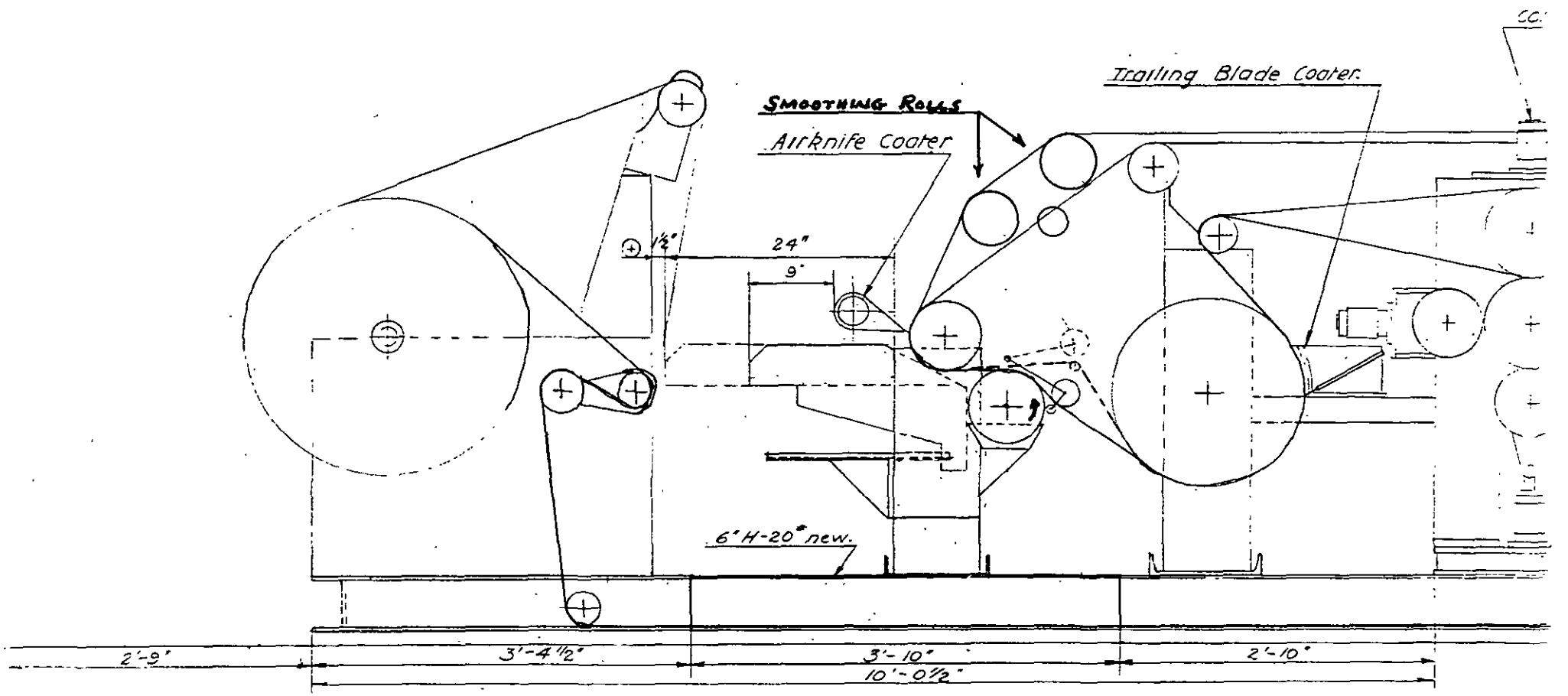
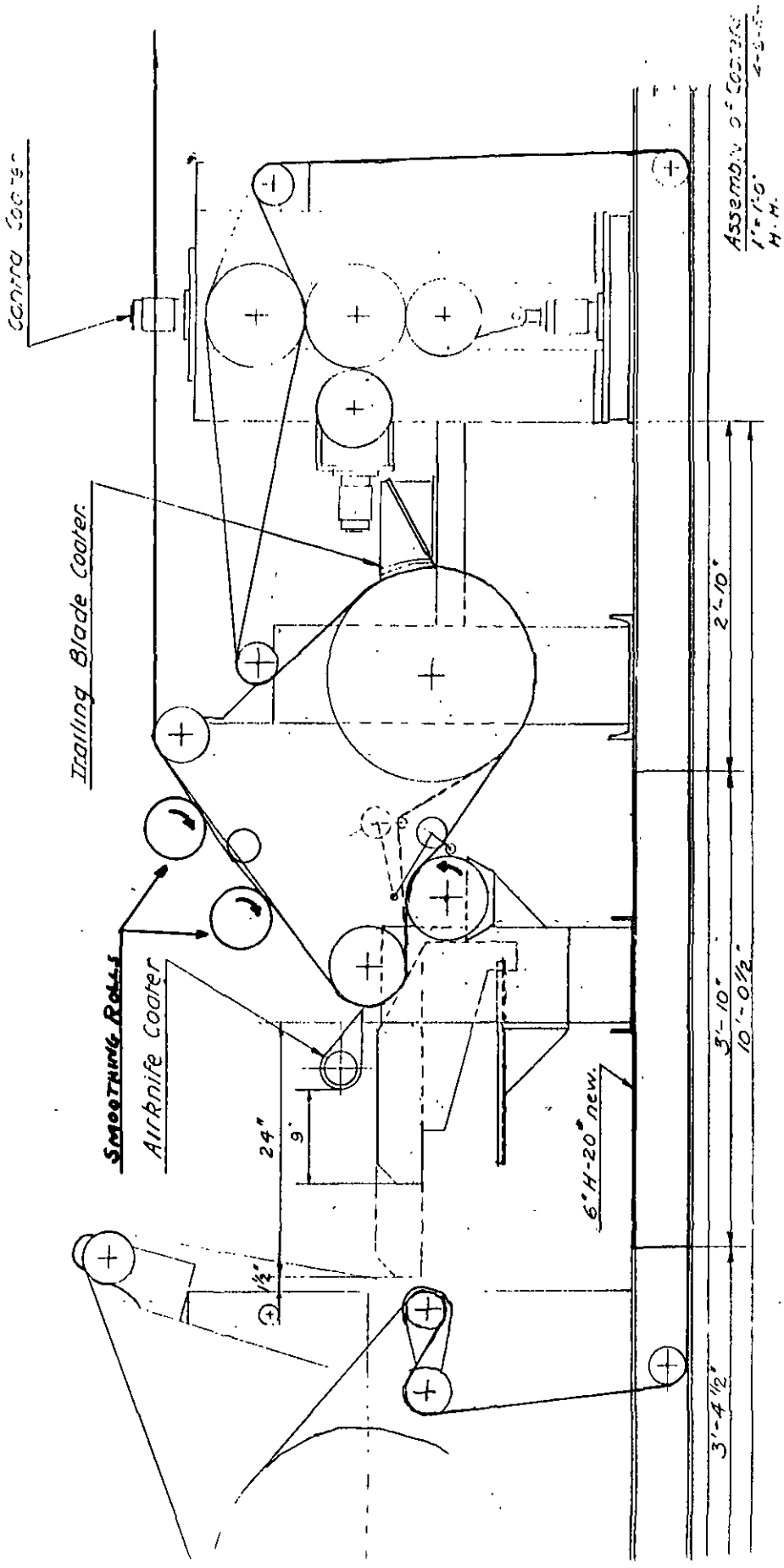


Figure 1. Threadup for air knife coating without operation of smoothing rolls. Red line indicates web. Rotational di rolls indicated by arrows.



knife coating with operations of two smoothing rolls. Red line indicates web. Rotational direction of driven by arrows.

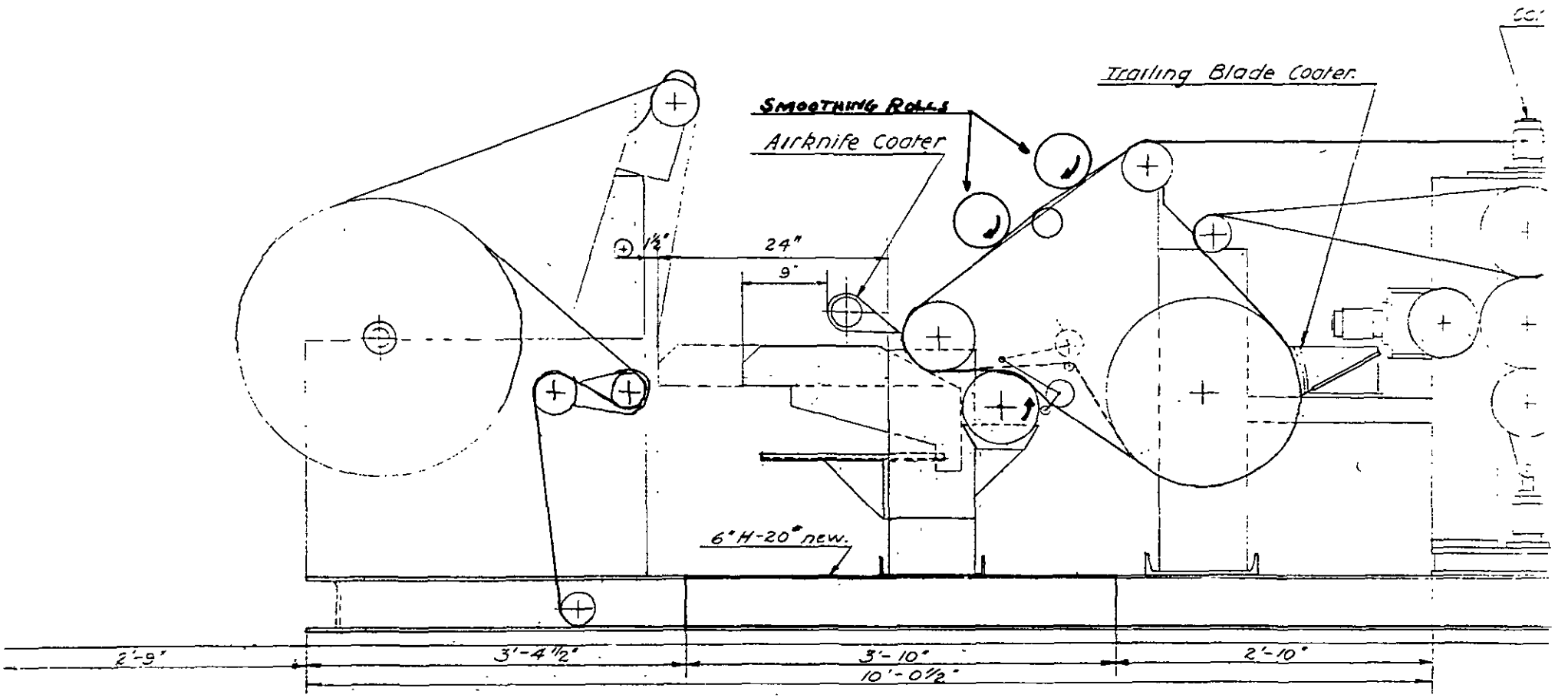
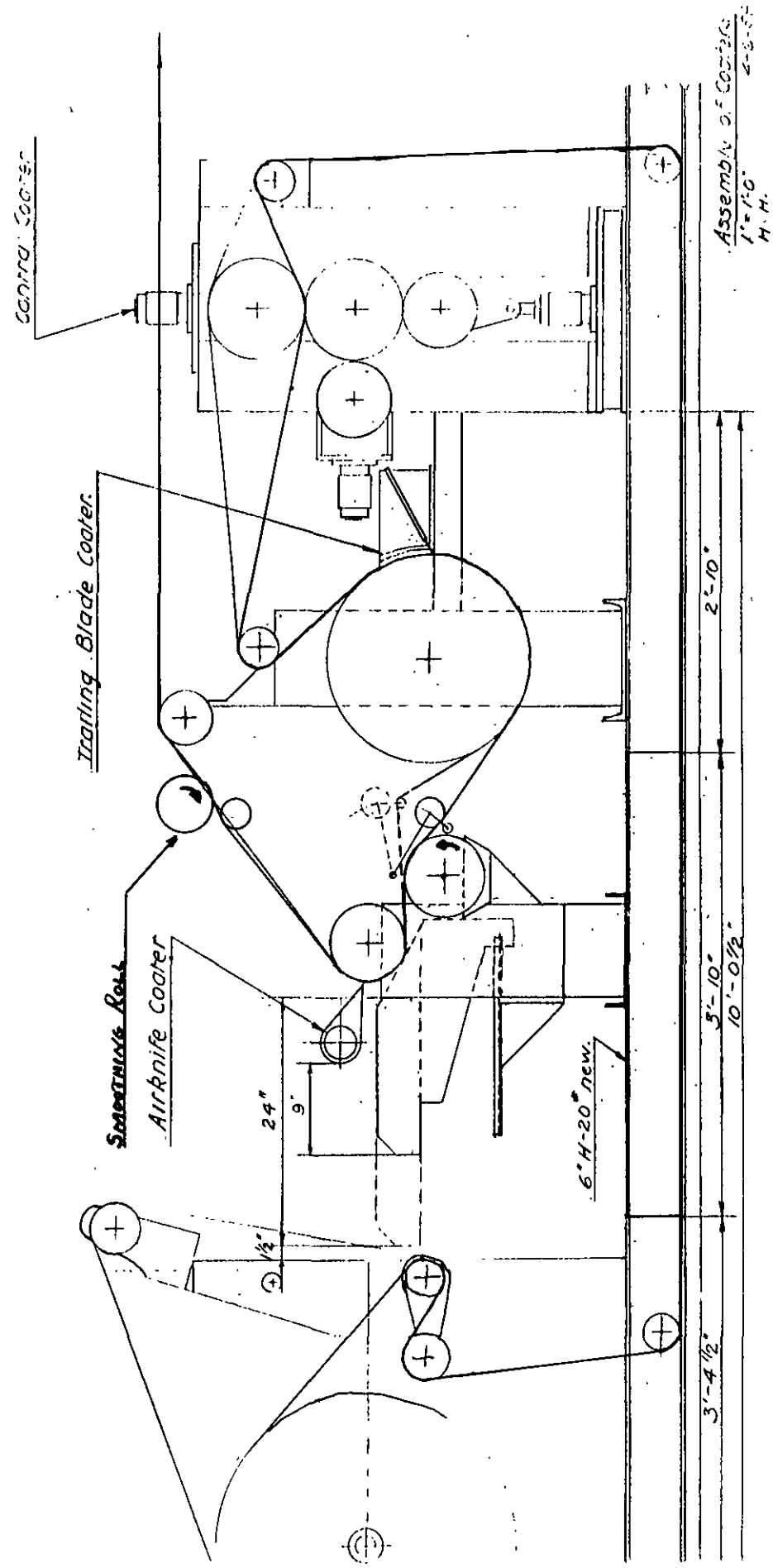


Figure 2. Threadup for air knife coating with operations of two smoothing rolls. Red line indicates web. Rotational rolls indicated by arrows.



r air knife coating with operation of one smoothing roll. Red line indicates web. Rotational direction of driven
ated by arrows.

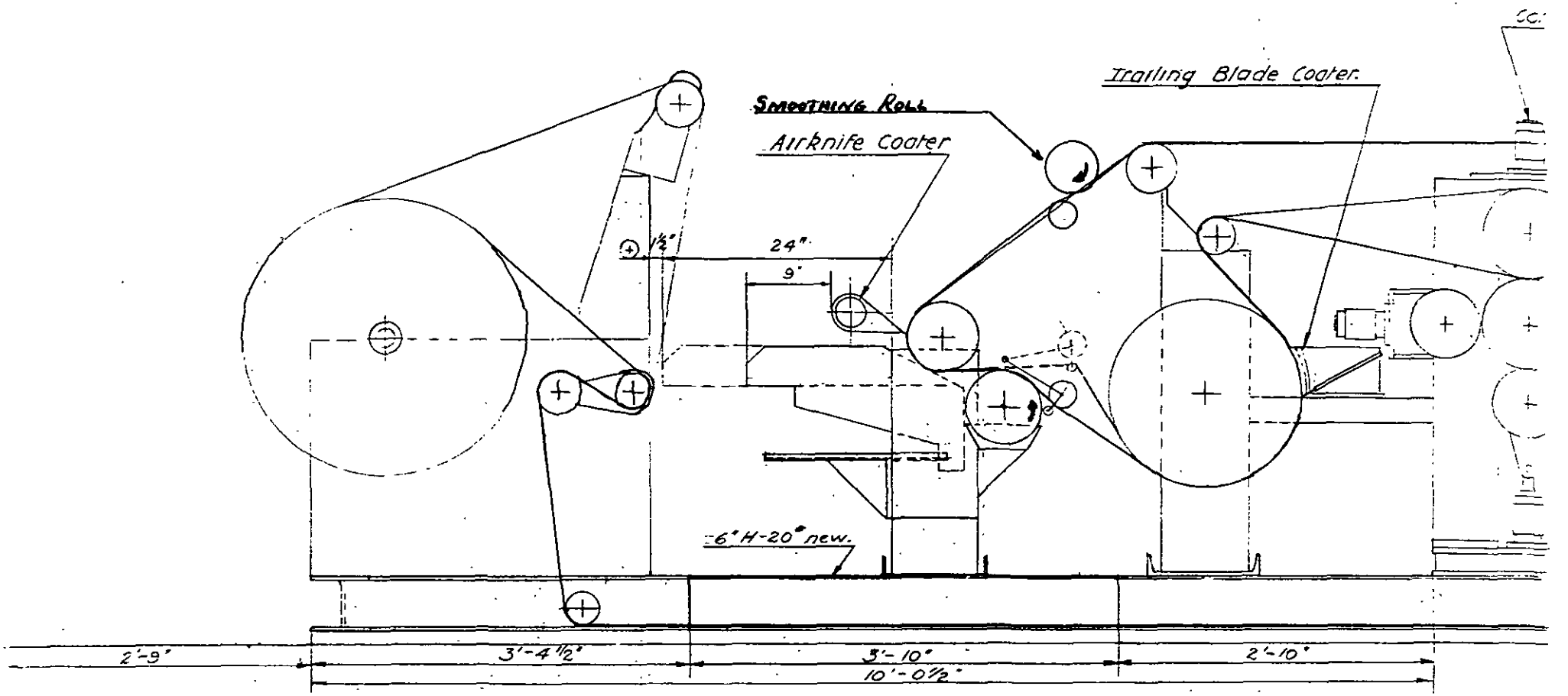


Figure 3. Threadup for air knife coating with operation of one smoothing roll. Red line indicates web. Rotational a rolls indicated by arrows.

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AIR KNIFE COATING TRIALS CONDUCTED FOR THE APPLETON COATED PAPER COMPANY

INTRODUCTION

On January 17 and 18, 1962 Messrs. John W. Allen and Richard Dearstine returned to the Institute to further pursue their evaluation of coating materials, defoamer and the use of smoothing rolls. These trials were a continuation of the trials conducted earlier in the month (Project 1956, Report No. 41). Mr. Donald Fird and the writer assisted in the trials.

An NCR coating material, designated Mark II, was used to coat the wire sides of two base stacks, Nekoosa Edwards' 23 lb/3000 sq. ft., 2 mil bread wrap and Bergstrom's 33 lb/3000 sq. ft., 2.5 mil stock. Eldefoam No. 2892 was used to control foaming. Knife edged metering bars were installed to meter the amount of coating transferred from the applicator roll to the web; the applicator roll was run with and against the web. The blow-off from the air knife and the overflow from the color pan were recirculated to the color pan.

PROCEDURE

The following air knife settings were used throughout the trials:

Angle to horizontal: 22°

Blade position: 1/4 inch below the centerline of the breast roll

Blade-breast roll gap: 0.129 in.

Blade orifice: 0.031 in.

These are the same settings used in the January 2 runs.

Metering bars made from 1/2 x 1-1/2 inch bar stock beveled at 45° on one side to a knife edge were installed on either side of the applicator roll depending on the rotation of the roll. On the front side of the applicator roll (roll rotating with the web) 1/8 x 1-1/2 inch rubber strips 3 inches long were clamped to the underside of the meter bar to serve as edge doctors. There was no room for mounting this sort of edge doctor on the back side of the roll so it was necessary to place a rod wrapped with rubber strips on the color pan between the applicator roll and the blow-off pan to doctor the coating.

A single smoothing roll was used. The position of this roll in relation to the web was unchanged from the single roll position used in the January 2 trials. The wrap was approximately 30°.

The machine threadup variations are shown in Figure 1.

RESULTS

A sample of the Mark II coating was obtained after the trials had been completed; its viscosity was measured with a Brookfield viscometer and by means of a Hercules rheogram. The following Brookfield viscosities were determined with a No. 1 spindle:

Viscosity, cp.	Spindle, rpm.
40.6	60
49.8	30
70.0	12
92.7	6

THE INSTITUTE OF PAPER CHEMISTRY EXPERIMENTAL COATER

Assembly of Coaters

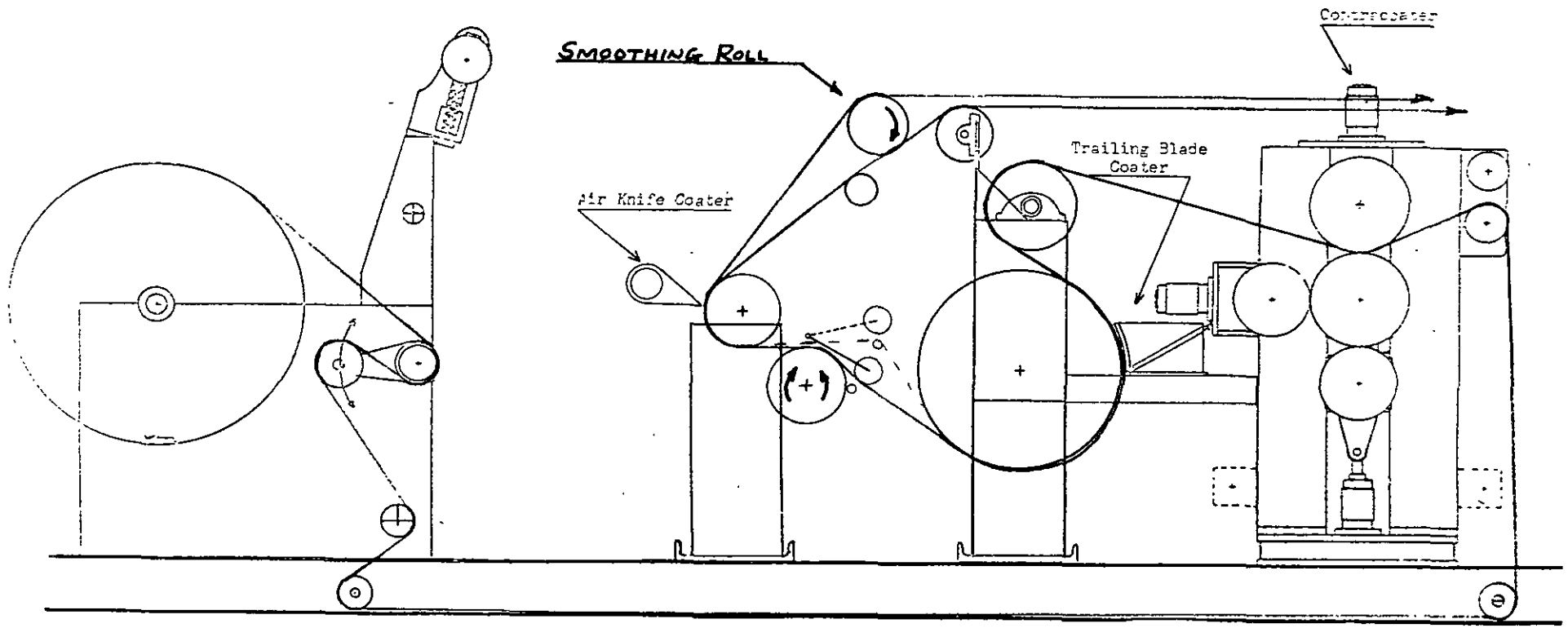

Figure 1. Variations in threadup for air knife coating with and without operation of smoothing roll.

The Hercules rheogram, run with a Bob A (large), showed no detectable thixotropic loop or dilatancy. The calculated viscosity at 1150 rpm was 1.77 centipoise.

A summary of the coating runs is presented in Tables I and II. Coating weights were determined from samples obtained by breaking the web during a run by the difference in the ovendry weights of coated and uncoated specimens.

Although the coating tended to foam, the effects were not evident on the coated samples. Fisheyes were noted on the applicator roll after defoamer had been added to the color but they did not appear on any of the samples.

Chatter marks began to appear on the samples immediately after the rotation of the applicator roll was reversed (Run 14). Changes in the smoothing roll speed did not rectify this (Runs 14 through 17), consequently, Runs 18 through 20 were made with increased applicator roll speed, web wrap, and various meter bar adjustments on the basis of a theory that the chatter marks were the result of a film-splitting situation occurring between the web and the applicator roll. None of the adjustments allieviated the condition. However, no chatter marks were observed from Run 21 in which neither the air knife nor the smoothing roll was used. It seems most likely that the reverse operation of the applicator roll produces cyclic fluctuations in the web tension sufficient to cause chattering at the smoothing roll. The difference in the coating weights on the samples coated with and without air knife metering indicates that such an excess of coating was metered from the web by the air knife that the effects of any film splitting condition between the applicator roll and the web on the coating per se would be negligible.

Since the January 2 trials a switch panel and a set of solenoid valves

TABLE I

Summary of Coating Runs Using 23 Lb. Nekoosa Edwards Base Stock

Run No.	Air Pressure, p.s.i.	Applicator Roll Speed[1] f.p.m.	Meter Bar Clearance, in.	Smoothing Roll Speed, f.p.m.[2]	Web Speed f.p.m.	Coating Weight lb/3000 sq.ft.	Remarks
1	2.0	100 ww	0.030	not used	600	1.5	
2	1.75	100 ww	0.030	not used	600	2.3	
3	1.75	100 ww	0.030	640	600	2.1	
4	1.75	100 ww	0.030	640	600	-	Slippage on rewind
5	1.75	100 ww	0.030	not used	600	2.3	Defoamer sprayed on color r just ahead of meter bar
6	1.75	100 ww	0.030	not used	600	-	Defoamer added to color, am in excess of 2%
7	1.75	100 ww	0.030	not used	600	-	Coating recirculated for 10 before trial

Air knife settings:

Blade-breast roll gap: 0.129 inches
Blade orifice: 0.031 inches

Notes: 1/ Rotation with web designated by "ww"

2/ Rotated against the web.

TABLE I

Summary of Coating Runs Using 23 Lb. Nekoosa Edwards Base Stock

Applicator Roll Speed[1] f.p.m.	Meter Bar Clearance, in.	Smoothing Roll Speed, f.p.m.[2]	Web Speed f.p.m.	Coating Weight lb/3000 sq.ft.	Remarks
100 ww	0.030	not used	600	1.5	
100 ww	0.030	not used	600	2.3	
100 ww	0.030	640	600	2.1	
100 ww	0.030	640	600	-	Slippage on rewind
100 ww	0.030	not used	600	2.3	Defoamer sprayed on color roll just ahead of meter bar
100 ww	0.030	not used	600	-	Defoamer added to color, amount in excess of 2%
100 ww	0.030	not used	600	-	Coating recirculated for 10 min. before trial

-breast roll gap: 0.129 inches
orifice: 0.031 inches

with web designated by "ww"

against the web.

TABLE II

Summary of Coating Runs Using 33 Lb. Bergstrom Base Stock

Run No.	Air Knife Air Pressure p.s.i.	Applicator Roll Speed[1] f.p.m.	Applicator Roll Meter Bar Clearance, in.	Smoothing Roll Speed, f.p.m.[2]	Web Speed f.p.m.	Coating Weight lb/3000 sq.ft.	Remarks
8	2.0	175 ww	0.045	980	1000	2.5	
9	1.25	175 ww	0.045	980	1000	5.7	
10	1.5	175 ww	0.045	980	1000	4.5	
11	not used	175 ww	0.045	not used	1000	8.1	
12	1.5	175 ww	0.045	not used	1000	4.3	
13	1.5	175 aw	0.030	980	1000	4.8	No edge doctors
14	1.62	175 aw	0.030	880	1000	4.5	Chatter marks on coating
15	1.62	175 aw	0.030	1100	1000	-	Air knife inadvertantly left i position
16	1.62	175 aw	0.030	1100	1000	-	Chatter marks on coating
17	1.8	175 aw	0.045	1000	1000	4.0	Meter bar did not contact coa applicator roll. Chatter m coating.
18	1.8	200 aw	0.040	1000	1000	4.6	Meter bar shifted away from r during run. Chatter marks coating.
19	1.8	200 aw	0.040	1000	1000	5.5	Coating was found to have set system was completely recir before following run. Chat marks on coating.
20	1.8	200 aw	0.040	1000	1000	4.4	Chatter marks on coating
21	not used	200 aw	0.040	not used	1000	13.5	

Air knife settings:

Blade-breast roll gap: 0.129 inches
Blade orifice: 0.031 inches

Notes: 1/ Rotation with web designated by "ww". Rotation against web designated by "aw".

2/ Rotated against the web.

TABLE II

Summary of Coating Runs Using 33 Lb. Bergstrom Base Stock

Applicator Roll Speed[1] f.p.m.	Meter Bar Clearance, in.	Smoothing Roll Speed, f.p.m.[2]	Web Speed f.p.m.	Coating Weight lb/3000 sq.ft.	Remarks
175 ww	0.045	980	1000	2.5	
175 ww	0.045	980	1000	5.7	
175 ww	0.045	980	1000	4.5	
175 ww	0.045	not used	1000	8.1	
175 ww	0.045	not used	1000	4.3	
175 aw	0.030	980	1000	4.8	No edge doctors
175 aw	0.030	880	1000	4.5	Chatter marks on coating
175 aw	0.030	1100	1000	-	Air knife inadvertantly left in "up" position
175 aw	0.030	1100	1000	-	Chatter marks on coating
175 aw	0.045	1000	1000	4.0	Meter bar did not contact coating on applicator roll. Chatter marks on coating.
200 aw	0.040	1000	1000	4.6	Meter bar shifted away from roll during run. Chatter marks on coating.
200 aw	0.040	1000	1000	5.5	Coating was found to have settled; system was completely recirculated before following run. Chatter marks on coating.
200 aw	0.040	1000	1000	4.4	Chatter marks on coating
200 aw	0.040	not used	1000	13.5	

breast roll gap: 0.129 inches
orifice: 0.031 inches

with web designated by "ww". Rotation against web designated by "aw".

against the web.

were installed in place of the hand valves in the vacuum system of the Fife edge control unit along with new hoses. The switch panel facilitated the operation of the system; it was possible to adjust the sensing device so that the cambering roll was centered at the null point of the sensor by adjusting the sensing device in relation to the web and switching to automatic centering until the cambering roll did not shift. It was necessary to throttle the oil flow to the cylinder at higher speeds, however, it was possible to achieve satisfactory operation by careful adjustment.

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PILOT COATER OPERATIONS FOR HOOKER CHEMICAL CORP. ORIENTATION PROGRAM

INTRODUCTION

On Thursday, November 15, 1962 a series of pilot coater trials were made for personnel of the Hooker Chemical Corp. participating in the Orientation Program in the Coating Field (Special No. 11,655) conducted by Dr. Garey. The purpose of these trials was to demonstrate some of the physical phenomena that occur during the application and metering of coating onto a web of paper. The reverse roll (also run with the web as a print roll application) and the air knife methods were used.

OPERATIONS

Raw Stock

In both the air knife and roll coater operations, the coating was applied to 42 lb/ream (24 x 38 in--500) Nekoosa-Edwards white coating grade stock caliper-ing 3.4 mils.

Coating Formulations

A high solids clay-calcium carbonate formulation with casein binder was used in the roll coating application. This color was diluted and latex was added for the air knife trials. The roll coater formulation was made of the following components:

Material	Amount, lb.	Percent, by wt.
HT-Predispersed Clay	150.0	35.65
Calcium Carbonate (Purecal M)	50.0	11.90
Casein	28.0	6.66
Water	191.5	45.55
Calgon	1.0	0.24
	420.5	100.00

Solids = 54.45%

The color was made up in the following steps:

1. The casein was slurried at 20% solids in cold water and heated to 60°C with agitation by a Lightnin' mixer. When the slurry reached 60°C 10% caustic soda was added and cooking was continued for one hour. Toward the end of the cook the material was almost gelatinous, making handling difficult.

2. The clay was dispersed at 72% solids in a Cowles dissolver. To facilitate the dispersion, 0.54 lb. of Calgon was added to the water prior to the addition of the clay.

3. An attempt was made to disperse the calcium carbonate at 70% solids using 0.50 lb. of Calgon with a Lightnin' mixer. The carbonate became lumpy and did not wet. The resulting lumpy mass was added to the clay slip and dispersed with the Cowles.

4. The casein was added to the clay-carbonate dispersion using a Lightnin' mixer for agitation. There was some indications of casein shock when it was added.

5. The formulation was diluted as required and 12% (solids) Dow 512R latex, on the basis of the solids in the color, which had been diluted to 45% solids was added for the air knife trials.

Results of solids determinations and Hercules Rheograms run on the coatings as they were used in the trials are listed in Table I. The Hercules Rheograms are shown in Figure 1.

TABLE I

COATING FORMULATIONS AND VISCOSITY

(Clay-Calcium Carbonate)

Number	Methods of Application	Binder	Solids %	Viscosity, Hercules at 1150 rpm, cp.	Rheology
1	Roll coater	Casein	56.8	Too dilatant	Very dilatant
2	Roll coater	Casein	45.2	63	Very slightly thixotropic
3	Air knife	Casein-Latex	32.8 before run 33.6 after run	9	Newtonian

Roll Coating

The conditions of the roll coating runs and the resulting coating weights are listed in Table II. Other variations in running conditions were made during the runs, however, these were of short duration since they were not optimum conditions for good coating or observation of phenomena such as film splitting. One such change was the reversal of the rotation of the rolls so that the applicator roll was running with the web; this operation resulted in severe tracking and a coating weight beyond the capacity of the drier. Samples of coated sheets from each run are appended to this report.

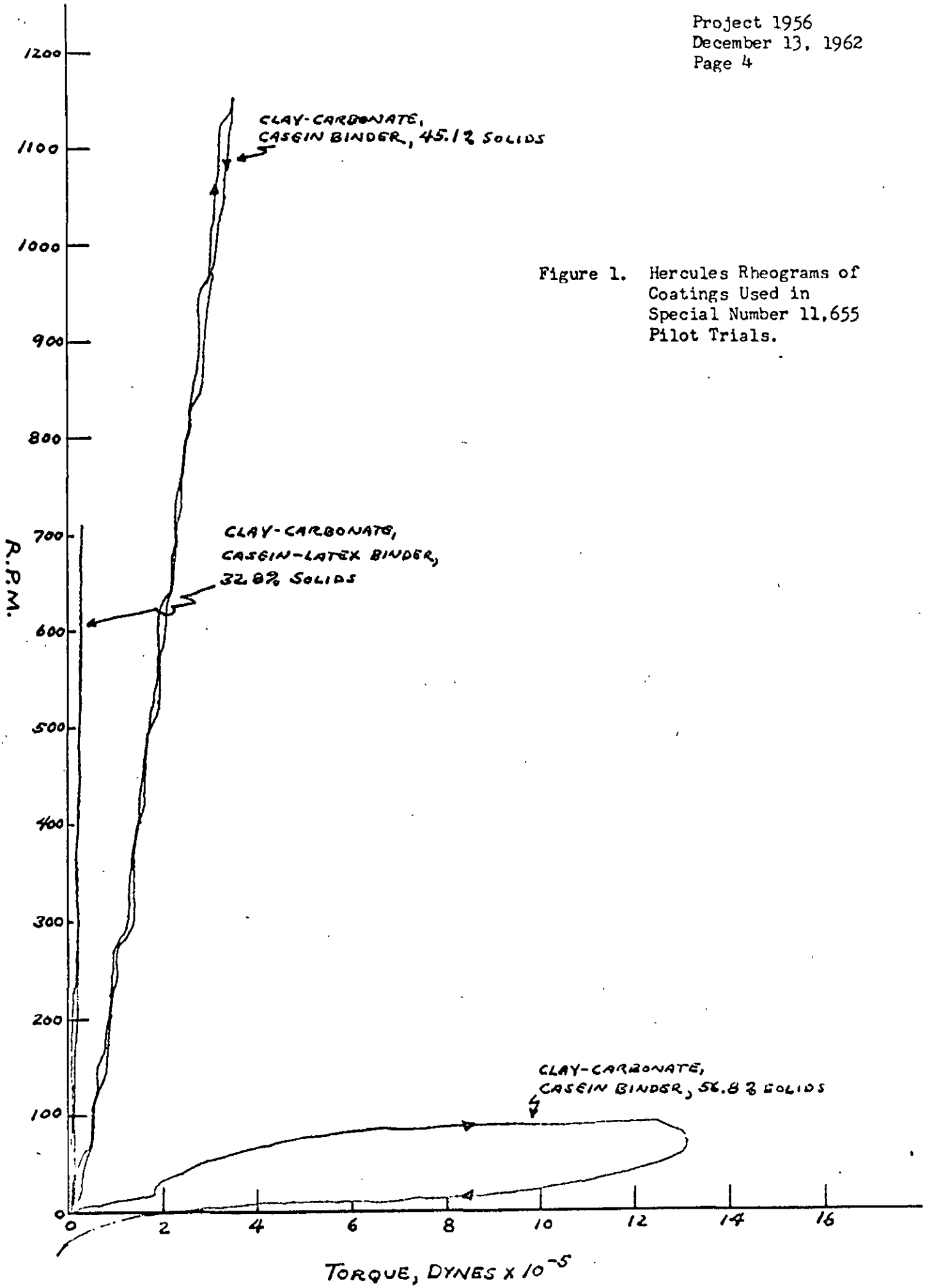

Figure 1. Hercules Rheograms of Coatings Used in Special Number 11,655 Pilot Trials.

TABLE II

HOOKER CHEMICAL CORP.: CONDITIONS AND RESULTS OF COATING RUNS WITH ROLL COATER

SPEC. NO. 11,655. TRIALS MADE ON NOVEMBER 15, 1962

Roll Clearance Settings: Pan-Applicator Roll 0.026 in.

Meter-Applicator Roll 0.003 in.

Web-Applicator Roll 0.003 in.

Run	Coating No.	Coating Solids, %	Coating Viscosity, cp.	Roll Speeds,[a] f.p.m. Applicator	Meter	Pan	Web Speed, f.p.m.	Coating Weight,[b] lb/3000 sq.ft.	Remarks
1	1	56.8	Very dilatant	21	24	16	50	6.41	Severe patterning; skip coating
2	2	45.2	63	21	10	16	50	7.42	Severe patterning
3	2	45.2	63	45	10	16	50	12.52	Some streaking, poor doctoring on meter roll
4	2	45.2	63	45	175	16	50	19.59	

[a] Applicator roll rotated against web; meter and pan rolls rotated against applicator roll.

[b] Air dry.

Air Knife Coating

In the air knife coating runs only the air pressure was varied; these runs are described in Table III. Samples of the coated paper are appended to this report.

TABLE III

HOOKER CHEMICAL CORP.: CONDITIONS AND RESULTS OF COATING RUNS WITH AIR KNIFE

SPEC. NO. 11,655. TRIALS MADE ON NOVEMBER 15, 1962

Air Knife Settings: Angle to Horizontal 22°

Orifice Located 0.25 in. Below Axis of Breast Roll

Orifice-Breast Roll Gap 0.12 in.

Orifice Opening 0.030 in.

Run	No.	Coating Solids, %	Viscosity, cp.	Color Roll Speed,[a] f.p.m.	Air Pressure, p.s.i.	Web Speed, f.p.m.	Coating Weight,[b] lb/3000 sq.ft.	Remarks
1	3	32.8	9	85	2.6	50	2.32	
2	3	32.8	9	85	1.0	50	3.11	
3	3	32.8	9	85	1.75	50	3.31	
4	3	32.8	9	85	5.0	50	3.90	Coating sprayed from air knife

[a] Rotated with web.

[b] Air dry.

Raw Stock

Contracoater Run 1.
Applicator Roll Speed: 21 f.p.m.
Meter Roll Speed: 24 f.p.m.
Coating Weight: 6.41 lb/3000 sq.ft.

Contracoater Run 2
Applicator Roll Speed: 21 f.p.m.
Meter Roll Speed: 10 f.p.m.
Coating Weight: 7.42 lb/3000 sq.ft.

Contracoater Run 3
Applicator Roll Speed: 45 f.p.m.
Meter Roll Speed: 10 f.p.m.
Coating Weight: 12.52 lb/3000 sq.ft.

Contracoater Run 4
Applicator Roll Speed: 45 f.p.m.
Meter Roll Speed: 175 f.p.m.
Coating Weight: 19.59 lb/3000 sq.ft.

Air Knife Coating - Run 1
2.6 p.s.i. air
Coating weight: 2.32 lb/3000 sq.ft.

Air Knife Coating - Run 2
1.0 p.s.i. air
coating weight: 3.11 lb/3000 sq.ft.

Air Knife Coating - Run 3
1.75 p.s.i. air
coating weight: 3.31 lb/3000 sq.ft.

Air Knife Coating - Run 4
5.0 p.s.i. air
coating weight: 3.90 lb/3000 sq.ft.